Research Note

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE

INTERMOUNTAIN FOREST & RANGE EXPERIMENT STATION
OGDEN UTAH

No. 96 June 1962

EFFECTIVENESS OF DDT FOR PREVENTING INFESTATION OF GREEN LOGS BY THE DOUGLAS-FIR BEETLE

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SUMMARY

Infestations of the Douglas-fir beetle may result from a buildup of beetles in down trees. To determine effectiveness of DDT in preventing infestation, a 2-percent emulsion was sprayed on green logs at rates of 3 to 4 gallons per 100 square feet of bark surface prior to beetle attack.

In the first test, sprayed logs were not attacked heavily for a period of 3 weeks. Thereafter, attacks increased and broods contained in them did not differ significantly from those in unsprayed check logs. However, the number and length of bark beetle egg galleries and number of woodborer larval mines were significantly smaller in sprayed logs.

A second test was conducted to determine if the petroleum solvent in the spray concentrate by itself would repel attack and to determine effectiveness of two treatments with DDT spray. Logs sprayed either once or twice with DDT had markedly fewer egg galleries and brood, but treatment with the petroleum solvent alone did not reduce attack or establishment of brood.

Results of these tests indicate that infestation of green logs and possibly live trees can be largely prevented by 2-percent DDT emulsion spray. Careful timing and uniform application are important.

The author acknowledges assistance of the following persons who helped with the study: Dr. William F. Barr, Department of Entomology, University of Idaho; John Henry, a graduate student of Dr. Barr; LeRoy N. Kline, summer assistant; and Donnis W. Owen and Abb H. Taylor, Foresters, Boise National Forest.

INTRODUCTION

The Douglas-fir beetle (Dendroctonus pseudotsugae Hopk.) is the most destructive insect enemy of Douglas-fir. The beetle is attracted to freshly felled logs and windthrown trees in which it may breed large numbers of progeny. The infestations which ensue may devastate whole stands of overmature trees. Methods are needed for preventing infestation of felled host material and for protecting especially valuable trees such as those around campgrounds and summer homes.

To help provide such a preventive treatment, a 2-percent DDT emulsion spray was tested on green logs. DDT was selected for testing because of its low cost, low mammalian toxicity and long residual life; because it is effective against related scolytids; and because it had not been tried against D. pseudotsugae.

LITERATURE

DDT has been used successfully to prevent infestation by various scolytid beetles other than the Douglas-fir beetle. Massey and Wygant (1954) reported that 3.2 times more untreated live trees were attacked by the Engelmann spruce beetle (Dendroctonus engelmanni Hopk.) over a 2-year period than those sprayed to a height of 20 feet with a 2-percent DDT emulsion. Also, most attacks in treated trees occurred above the sprayed part of the stem and the brood was sparse, whereas those in untreated trees were normal.

Struble and Hall (1955), reporting the results of Patterson (1949),[1/] advocated application of 5-percent DDT oil spray at a rate of 2 ounces per square foot of bark to prevent attack by the California five-spined engraver (Ips confusus (Lec)). Such a spray completely protected logs for 40 to 75 days after treatment.

In the eastern United States, control of Dutch elm disease is recommended (Whitten, 1956) by application of 2-percent DDT (with a hydraulic sprayer) or 12.5-percent DDT (with a mist blower). The spray is effective in preventing feeding scars by the smaller European elm bark beetle (Scolytus multistriatus) which carries the disease. Doane (1958) reported that emulsion sprays containing 5-percent and 2-percent DDT were equal or superior to other test insecticides for preventing feeding marks or "scores" that penetrated to the xylem surface.

1/ Patterson, J. E. Some experiments in the control of several western bark beetles by use of toxic sprays. Forest Insect Laboratory, Berkeley, Calif. (Manuscript report). 1949.

Massey (1960) added the southwestern pine beetle (Dendroctonus barberi Hopk.) to the list of scolytids against which 2-percent DDT emulsion is effective in preventing infestation. Of 745 treated ponderosa pine trees, only three had become infested by September after two applications of the spray in May and July. In contrast, 103 of 286 intermixed check trees became infested during the same interval of time.

METHODS

The initial test utilized 11 pairs of cull logs left during logging. An average of 3 gallons of spray was applied (fig. 1) per 100 square feet of bark surface on May 5, 1959. The logs varied considerably in diameter (10 in. to 40 in.) and in length (5 ft. to 15 ft.). The average log per treatment was as follows:

	Treatment	
	2% DDT	Check
Diameter (in.)	20	18
Length (ft.)	7	8
Bark area (sq. ft.)	35	41

After treatment, the logs were examined weekly for presence of beetle attack until mid-June, at which time the beetle flight appeared to have ended. Final results were evaluated between June 24 and July 13, 1959.

To evaluate Douglas-fir beetle egg galleries and brood, two sizes of sampling unit were used to see which worked better. Dimensions of these sampling units were 6 by 12 inches and 6 by 48 inches. They were cut from the underside of the logs. A third size of sampling unit, measuring 12 by 12 inches, was cut from the top of each log to determine effect of treatment on infestation by wood borers (Buprestidae and Cerambycidae). Previously, the author (1962b)[2/] had observed that Douglas-fir beetles occur in greatest density and most uniformly on the shaded underside of logs, whereas wood borers occur most abundantly on the sun-exposed upper side.

2/ Furniss, Malcolm M. Infestation patterns of Douglas-fir beetle in standing and windthrown trees in southern Idaho. Submitted for publication, Jour. Econ. Ent. 1962b.

Figure 1.--Spray was applied to green logs at rates of 3 and 4 gallons per 100 sq. ft. of bark surface.

In the second test, 24 freshly cut logs, 3 feet long, were placed upright and treated as shown in the tabulation at a rate of approximately 4 gallons per 100 square feet of bark.

Treatment	No. of logs	Diameter (av.,in.)	Length (av.,ft.)	Bark area (av.,sq.ft.)
2% DDT, sprayed once, May 9	6	16.2	3	12.8
2% DDT, sprayed twice, May 9 and 23	6	14.6	3	11.5
2% Aromatic solvent, sprayed twice, May 9 and 23	6	14.6	3	11.4
Check	6	14.0	3	11.0

The second DDT treatment and the inclusion of aromatic solvent were suggested by results of the first test. After treatment, the logs were examined five times between May 16 and June 12. During these examinations, the number of Douglas-fir beetle attacks was counted on the outside of a 1-foot-wide band around the middle of each log.

To evaluate egg galleries and brood, four samples were cut from cardinal directions around the middle of each upright log between June 14 and 30, 1960. The sampling unit was a circular 1/10-square-foot piece of bark cut with a bark punch (Furniss, 1962a).[3/]

RESULTS

1959 Test

First attack by the Douglas-fir beetle was noted on May 13 on a check log. For approximately 3 weeks the sprayed logs were attacked sparingly in comparison with check logs. Thereafter, attacks on sprayed logs increased markedly, but totaled only 22 percent of those on check logs when beetle flight had ended, as shown in the tabulation:

Treatment	Total number of Douglas-fir beetle attacks on outside of logs[1/]
2% DDT	191
Check	880

1/ Without regard to success of attack

3/ Furniss, Malcolm M. A circular punch for cutting samples of bark infested with beetles. Canad. Ent. Accepted for publication. 1962a

To determine how many beetles were successful in constructing galleries and establishing brood, bark samples were removed as described under "methods" with these results:

Factor sampled	Treatment DDT	Treatment Check	Significance of difference
Douglas-fir beetle			
Live brood, no. per sq. ft.			
6" x 12" samples	115.5	209.5	N.S.
Egg galleries, inches per sq. ft.			
6" x 12" samples	12.4	41.4	**
6" x 48" samples	11.3	41.4	**
Egg galleries, no. per sq. ft.			
6" x 12" samples	4.5	10.7	*
6" x 48" samples	3.3	8.0	*
Wood borers			
Larval mines, no. per sq. ft.			
12" x 12" samples	3.0	15.3	*

N.S. = Not significant
* = Significant at 0.05 level
** = " " 0.01 "

Many attacking beetles were found dead in the phloem of sprayed logs (fig. 2); they had penetrated to the sapwood but were unable to proceed farther. This poisoning action is shown by the significantly reduced number and length of egg galleries. Sprayed logs also had 94 fewer live brood per square foot but the difference was not significant. Lack of significance was due to two logs which had more brood than did their untreated pairs. As shown in the following tabulation, six sprayed logs had no brood, whereas all check logs had some brood.

Log No.	Treatment DDT	Treatment Check
1	0	98
2	242	244
3	122	4
4	674	274
5	120	414
6	0	324
7	0	92
8	0	332
9	112	320
10	0	54
11	0	148
Av.	115.5	209.5

Presence of more brood in the sprayed member of two logs may have been due to differences in egg production between beetles and the fact that brood on a sample may have originated from galleries that were off the sample. If more samples had been taken, variation from these sources might have canceled out.

Figure 2.--DDT killed most beetles before they could construct egg galleries. Point attacks (arrows) resulted when female beetles penetrated the phloem and died.

1960 Test

Attacks were noted first on logs of all treatments on May 16. The number of attacks that each log eventually sustained, as determined on June 12 after flight had nearly ended, are shown in the following tabulation. A log treated twice with only petroleum solvent contained the most attacks per 1-foot-wide band. Two treatments with DDT gave best protection against attack.

Replicate	Treatment and number of attacks[1/]: 2% DDT applied once	2% DDT applied twice	2% Aromatic petroleum solvent applied twice	Check
1	12	1	38	21
2	0	0	1	1
3	2	0	16	13
4	0	0	0	5
5	6	0	31	29
6	27	5	59	22
Total	47	6	145	91

1/ Without regard to success of attack.

Results obtained when bark punch samples were cut from the logs between June 14 and 30 were:

Treatment	Replicates (No.)	Samples (No.)	Live parent beetles (No./sq. ft.)	Live progeny (No./sq. ft.)	Egg galleries (No./sq. ft.)	Egg galleries (in./sq. ft.)
2% DDT, once	6	24	0	1.7	2.9	1.2
2% DDT, twice	6	24	0	7.1	0	0
2% Solvent, twice	6	24	5.8	251.7	21.7	50.2
Not sprayed	6	24	1.2	127.9	15.4	40.9

Effectiveness of the DDT treatments is evident from the data in this tabulation. No practical difference existed between logs treated once and those treated twice with DDT. The petroleum solvent treatment effected no control. The greater total infestation of logs in this treatment compared to infestation in the check logs is presumed due to chance rather than to attraction.

DISCUSSION

Use of cull logs left after logging had disadvantages. These logs varied greatly in diameter and length and were difficult to pair for treatment. Since their underside rested on the ground, it was difficult to spray them uniformly and to observe attacks. Cutting fresh logs for the second test overcame these disadvantages. Also, freshly cut logs appeared to be more attractive to beetles and it was possible to locate the logs in an area of high beetle population (although the data indicate that this may not have been true for the 1960 test).

Presence in 1959 of an oillike odor during the initial 3-week period, when sprayed logs were attacked sparingly, suggested a repelling effect. Breakdown of this immunity from attack after 3 weeks seemed due to disappearance of oil by evaporation and washing, aided by washing away of DDT by spring storms. For these reasons, the 1960 test included use of petroleum solvent alone to test its repellency and a second treatment with DDT to replenish any washed away. However, the pattern of attack observed in 1959 did not occur in the 1960 test. Differences in weather and number of beetles in flight during the two tests may explain why the 1959 pattern did not recur. Results of the 1960 test did not confirm the supposition that petroleum solvent will repel attack. A second application of DDT reduced attack, but one application of DDT lowered the successful infestation of phloem to a satisfactory level.

Of the sampling units used to evaluate bark beetle infestation in the logs, the 1/10-square-foot circular sample worked best. Its use permitted taking of more samples per log, and thereby provided a more representative evaluation around the circumference. The average number of egg galleries on 6- by 12-inch samples was comparable to, but slightly greater than, that on 6- by 48-inch samples. Considering the mechanics of obtaining samples and data on them, as well as the characteristics of the data, the order of preference of sampling units was: (1) 1/10-square-foot circular punch sample, (2) 6- by 12-inch sample, and (3) 6- by 48-inch sample. For counting brood in check logs, the largest sample was far too time-consuming to be feasible.

Initial applications of spray were timed to nearly coincide with start of beetle flight. Close timing was important because heavy storms occurred often during spring and could wash away some of the insecticide. Uniform application was important, too, because beetles attack in crevices that may be protected from spray by protruding bark or by contact with the ground. With proper timing and uniform application, 2-percent DDT emulsion spray appears to offer an effective preventive treatment for green logs or possibly individual live trees where their value and the threat of infestation are sufficient to justify its use.

LITERATURE CITED

Doane, Charles C.
1958. The residual toxicity of insecticides to Scolytus multistriatus. Jour. Econ. Ent. 51: 256-257.

Massey, Calvin L.
1960. DDT--a preventive control for the southwestern pine beetle. U.S. Forest Serv. Rocky Mtn. Forest & Range Expt. Sta. Res. Note 40, 1 p.

_____ and N. D. Wygant
1954. Biology and control of the Engelmann spruce beetle in Colorado. U.S. Dept. Agr. Cir. 944, 35 pp., illus.

Struble, George R., and Ralph C. Hall
1955. The California five-spined engraver, its biology and control. U.S. Dept. Agr. Cir. 964, 21 pp., illus.

Whitten, Russell R.
1956. Protecting against Dutch elm disease. U.S. Forest Serv. Central States Forest Expt. Sta. Misc. Release 10, 14 pp., illus.